Evaluating the Accuracy of the Estimate At Completion

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Overview

- Background
  - Terminology
  - EAC Formula
- EAC evaluation
  - Three techniques
  - Research Results

Estimate At Completion(EAC)

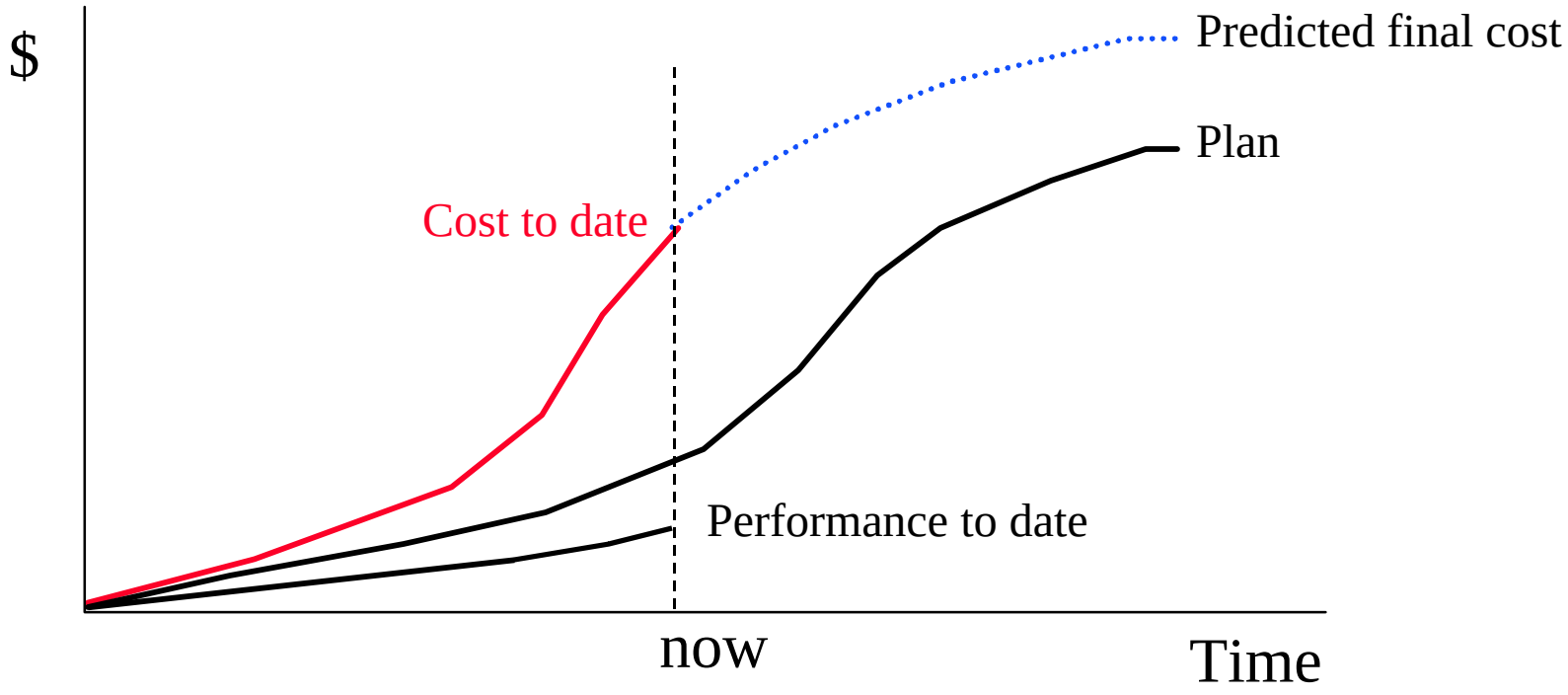
- Column 8 of DOD *Cost/Schedule Status Report*
- Column 15 of DOD *Cost Performance Report*
- Accuracy controlled by EVMS Criteria
- Factors to consider

  - Actual Costs to date
  - Performance to date
  - Cost and schedule variances
  - Reliability and relevance of data

  Overhead and Inflation rates
  Future performance on work
  Changes to requirements
  Organizational culture

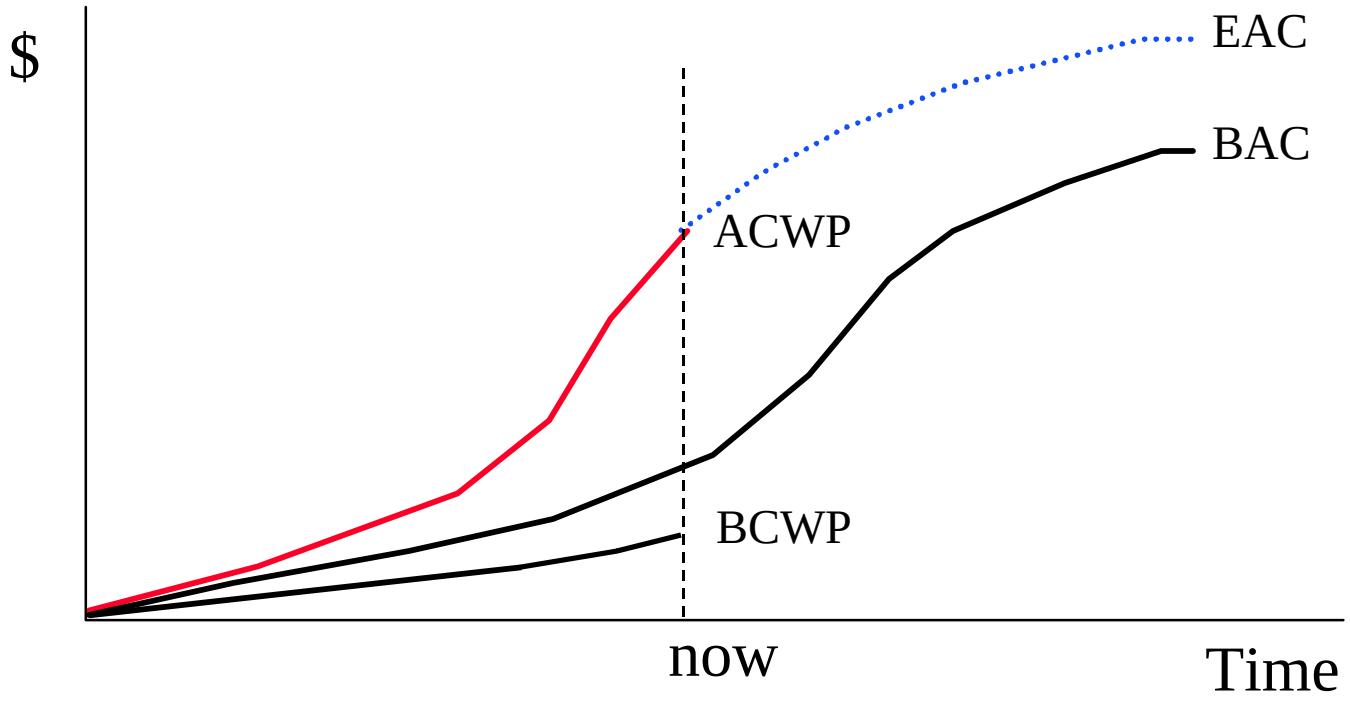
EAC Formula

EAC = Costs to date + Estimated Cost of Remaining Work



EAC Formula

EAC = ACWPcum + [(BAC - BCWPcum)/Performance Factor]



Performance Factor

Usually a performance index:

- CPI
- SPI
- Combination of CPI and SPI
  - w1(CPI) +w2(SPI), where w1 +w2 =1
  - CPI x SPI

Cost Performance Index

Example Data
BCWSc = $10 million
BCWPc = $8 million
ACWPc = $12 million
BAC = $20 million
LRE = $25 million

CPI = BCWP/ACWP **= 8 / 12 = 0.67**

Interpretation

Cumulative, Current, Average

Schedule Performance Index

Example Data
BCWSc = $10 million
BCWPc = $8 million
ACWPc = $12 million
BAC = $20 million
LRE = $25 million

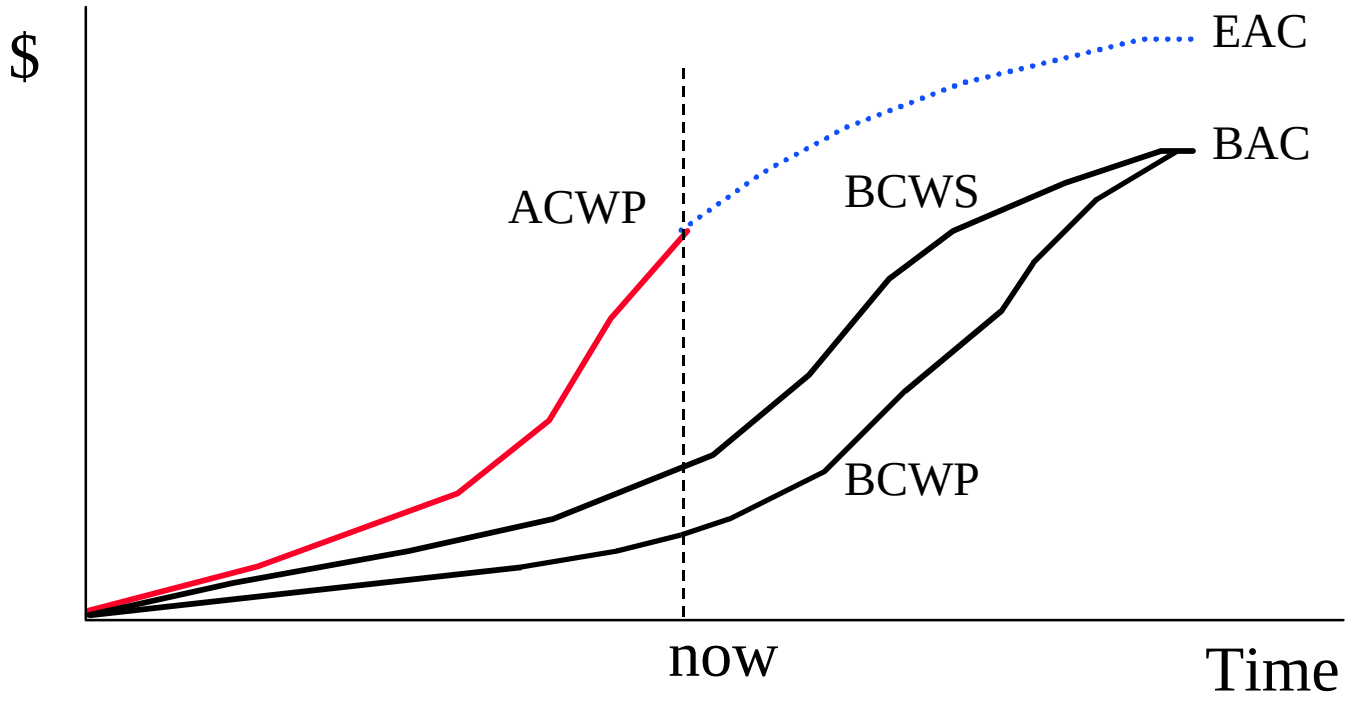
SPI = BCWP / BCWS **= 8 / 10 = 0.8**

Interpretation

Cumulative, Current, Average

Value is 1 at end of contract

BCWS = BCWP = BAC
when all work is completed



Combinations of CPI and SPI
w1(CPI) + w2(SPI)

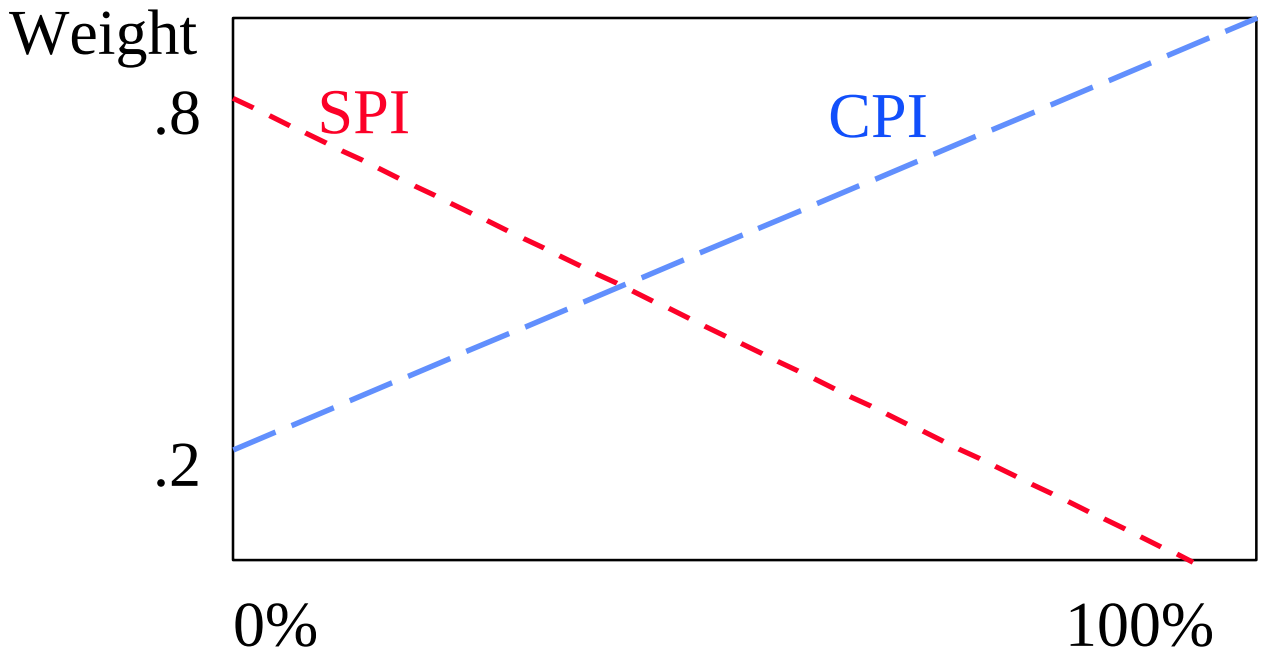
Example Data
BCWSc = $10 million
BCWPc = $8 million
ACWPc = $12 million
BAC = $20 million
LRE = $25 million

- .8(CPI) + .2(SPI) is an AF favorite
- Always between CPI and SPI

.8 (.67) + .2 (.8) = 0.69

Combinations of CPI and SPI
w1(CPI) + w2(SPI)

Sometimes based on Percent Complete:



Combinations of CPI and SPI
CPI x SPI

Example Data
BCWSc = $10 million
BCWPc = $8 million
ACWPc = $12 million
BAC = $20 million
LRE = $25 million

- An OSD favorite
- When CPI <1 and SPI < 1, SCI <<1

0.67 x 0.80 = 0.53

Twelve index-based EAC formulas

Index	*Monthly*	*Cumulative*	*Average*
CPI	x	x	x
SPI	x	x	x
w1(CPI) + w2(SPI)	x	x	x
CPI x SPI	x	x	x

Which one is best?

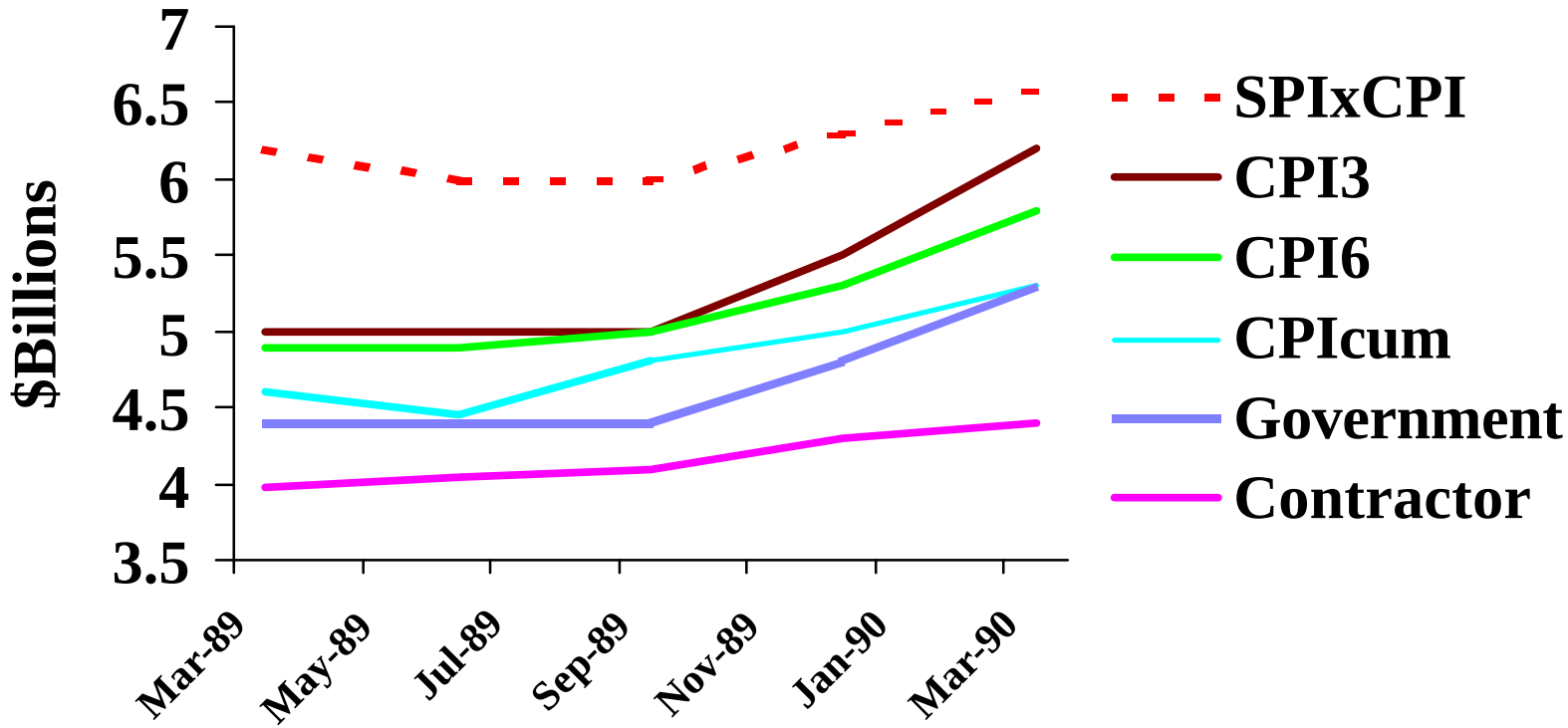
A-12 CPR Data (April 1990, $MIL)

BCWS	BCWP	ACWP	SV	CV	BAC	LRE	VAC
2080	1491	1950	-589	-459	4046	4400	-354

Index	*Value*	*EAC*
CPI x SPI	0.5481	6,612
SPI	0.7168	5,514
.8CPI + .2SPI	0.7551	5,334
CPI	0.7646	5,292

Which EAC is best?

Estimates at Completion
A-12 Program



Evaluating the EAC

1. Compare the CV to the VAC

CV	VAC	Implication
-459	**-354**	**LRE too small**

DOD Experience:

Once a contract is more than 15-20% complete, the final overrun will be worse than the present overrun

(Christensen/Wilson 1992)

Evaluating the EAC

2. **Compare the CPI with the $TCPI_{LRE}$**

CPI	**TCPI**	**Implication**
0.7646	**1.043**	**LRE is too small**

$TCPI_{LRE}$ = (BAC - BCWPcum) / (LRE - ACWPcum)

= (4046 - 1491) / (4400 - 1950)

DOD Experience:

Once a contract is over 20% compete, the cum CPI does not change by more than 10 percent, and in most cases it only worsens (Christensen/Heise 1993)

Evaluating the EAC

3. **Compare to a range of independent EACs**

LRE	IEAC floor	IEAC ceiling	Implication
4400	**5292**	**6612**	**LRE is too low**

DOD Experience

CPI-based EAC is floor to final cost

SCI-based EAC is often the most accurate estimate

(Christensen 1996)

Evaluating the EAC

DOD Experience: No single EAC formula is always best.

(Christensen, Antolini, McKinney 1992)

Navy (Covach, et al., 1981 14 Development, 13 Production)	
State of completion	**Best index-based formula**
Early (0-40%)	CPI3, CPI6, SCIc
Middle (20-80%)	CPI3, CPI6, CPIc, SCI
Late (60-100%)	CPI3, CPI6, CPI12

Army (Howard and Bright, 1981, 11 Develoment)	
State of completion	**Best index-based formula**
Early (0-40%)	Regression, Composite, SPIc, SCI
Middle (31-80%)	CPI3, CPI6, CPI12, SCI
Late (81-100%)	CPIc, SCI

Evaluating the EAC

DOD Experience: No single EAC formula is always best.

(Christensen, Antolini, McKinney 1992)

Air Force (Riedel and Chance, 1989 16 Development 40 Production)						
Phase	**System**	**25%**	**50%**	**75%**	**100%**	**Overall**
Devel	Aircraft	SCIc	CPI3	CPI3	20/80	SCIc
Prod	Aircraft	SCIc	CPI3	SCIc	CPIc	SCIc
Devel	Avionics	SCIc	CPI3	SCIc	CPIc	CPI3
Prod	Avionics	20/80	SCIc	20/80	SCIc	20/80
Devel	Engine	CPImon	SCIc	CPI3	CPI3	CPI3
Prod	Engine	PC	CPIc	SCIc	PC	CPIc

Organizational Culture and the EAC

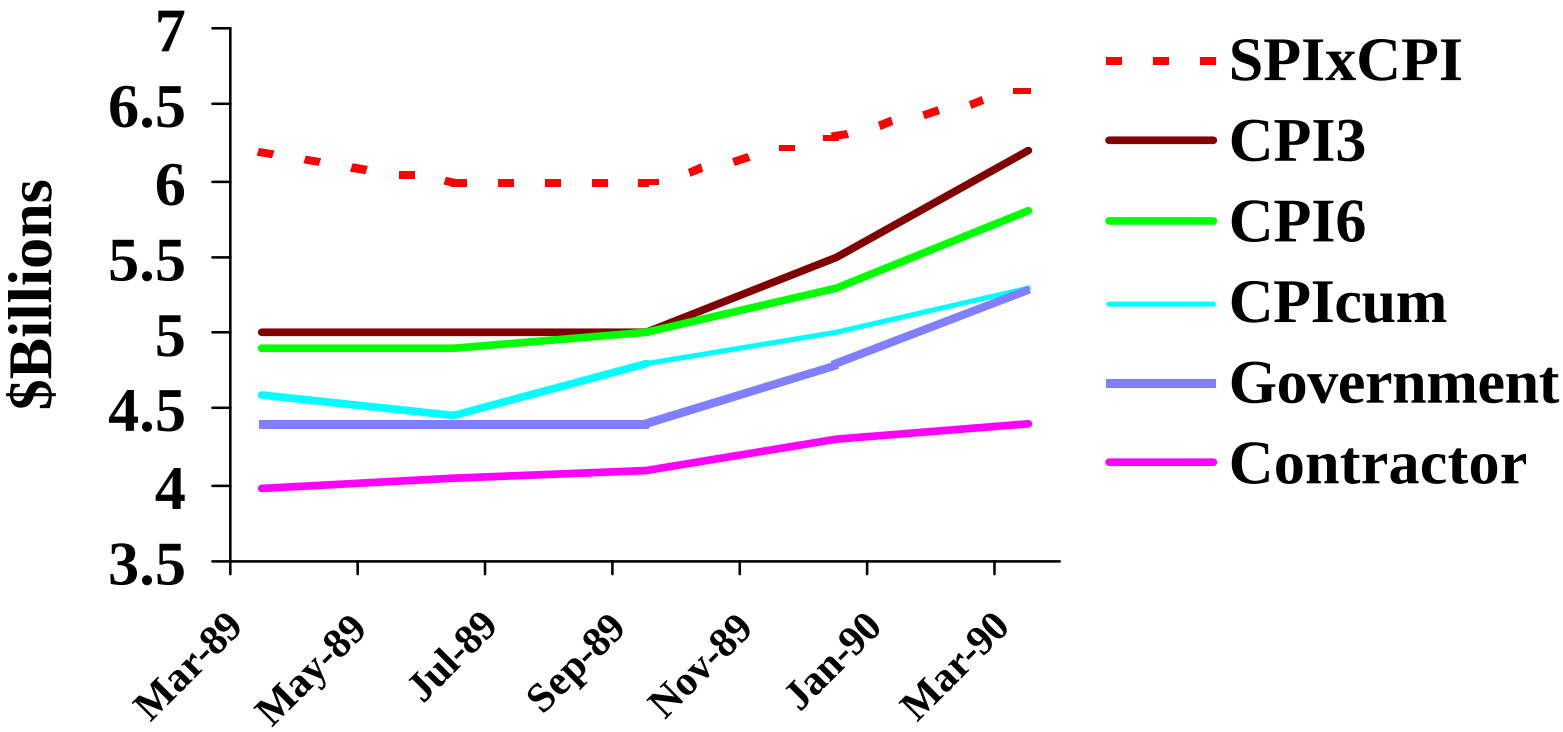
- Accuracy controlled by EVMS Criteria
- Factors to consider
  - Actual Costs to date
  - Performance to date
  - Cost and schedule variances
  - Reliability and relevance of data
  - Overhead and Inflation rates
  - Future performance on work
  - Changes to requirements
  - **Organizational culture**

Organizational Culture and the most likely EAC

- Program managers do not support EACs most likely to be experienced on their programs.

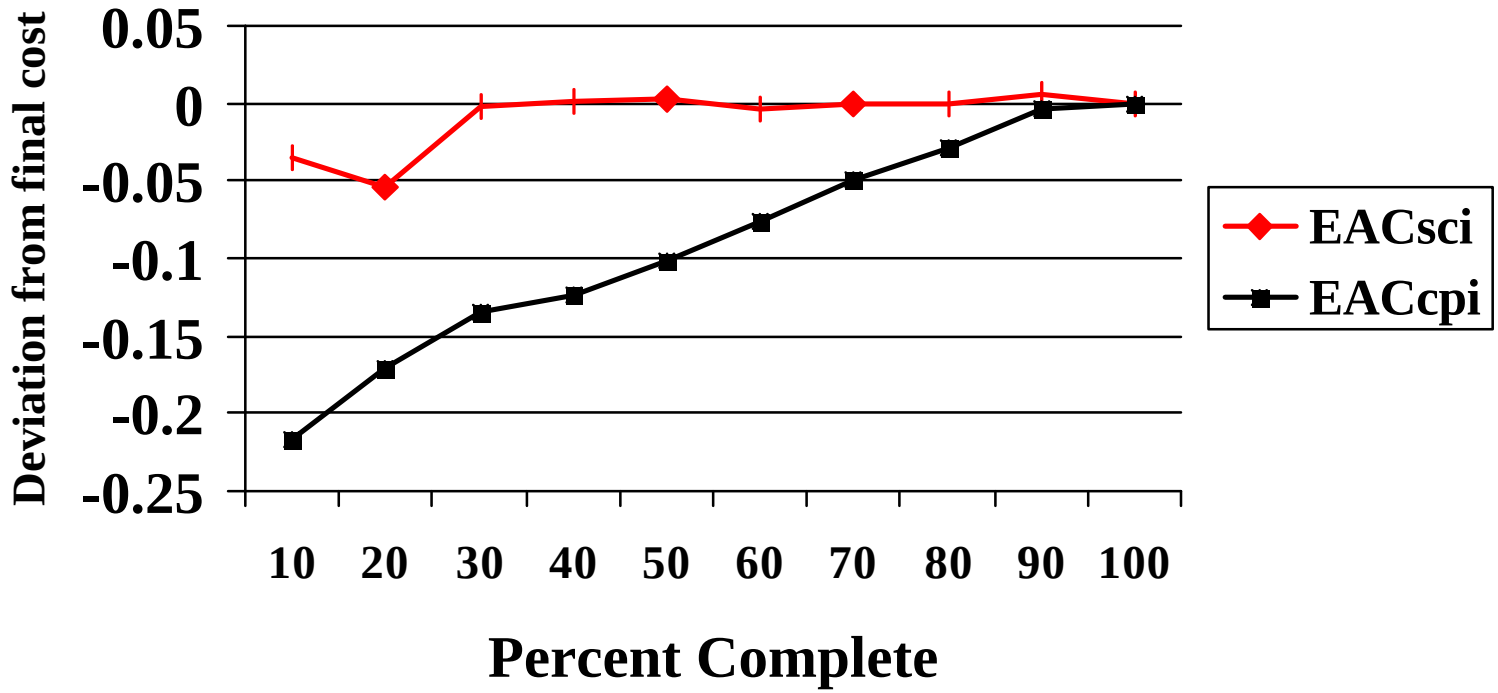
- Instead they support EACs most likely to be tolerated by OUSD and Congress.

Estimates at Completion
A-12 Program



Why were the contractor and government EACs the smallest?

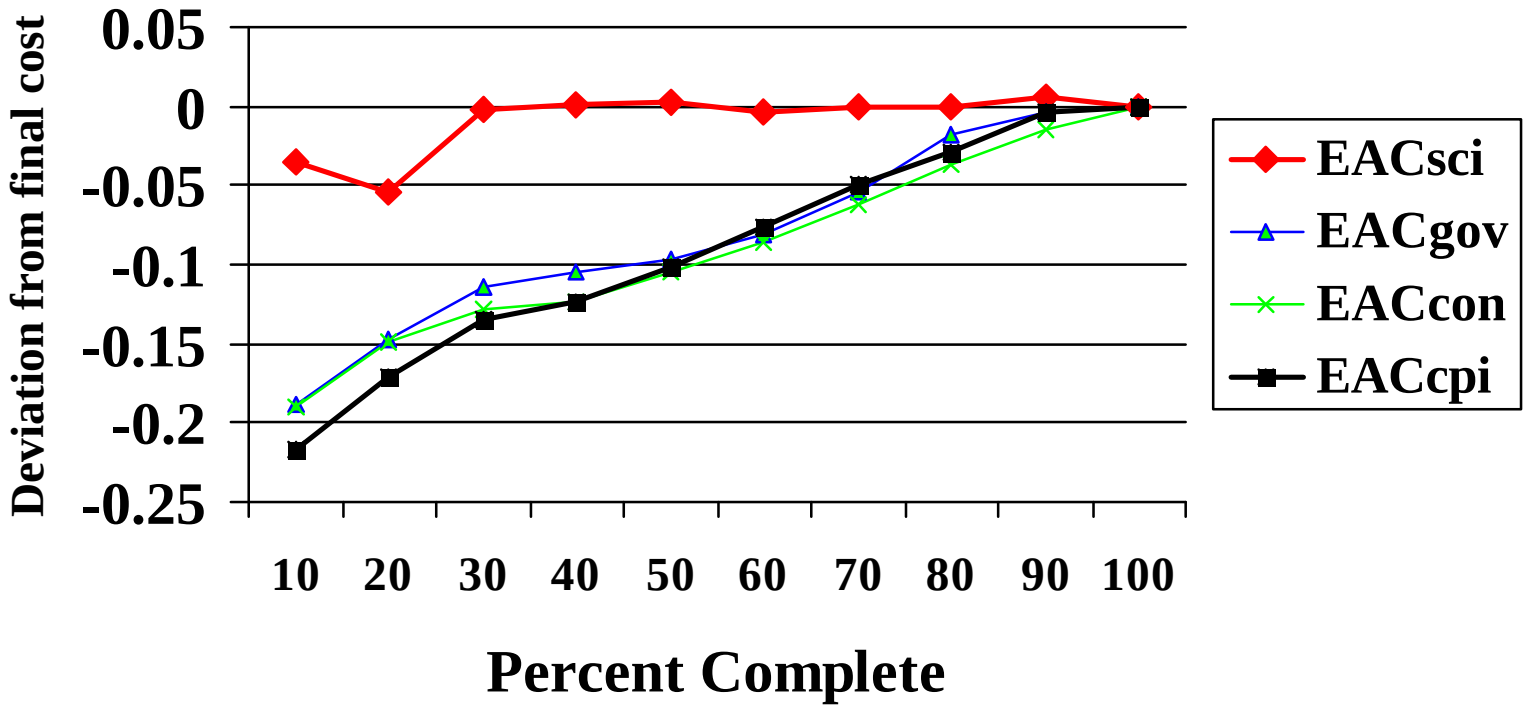
EAC Comparisons
(64 contracts)



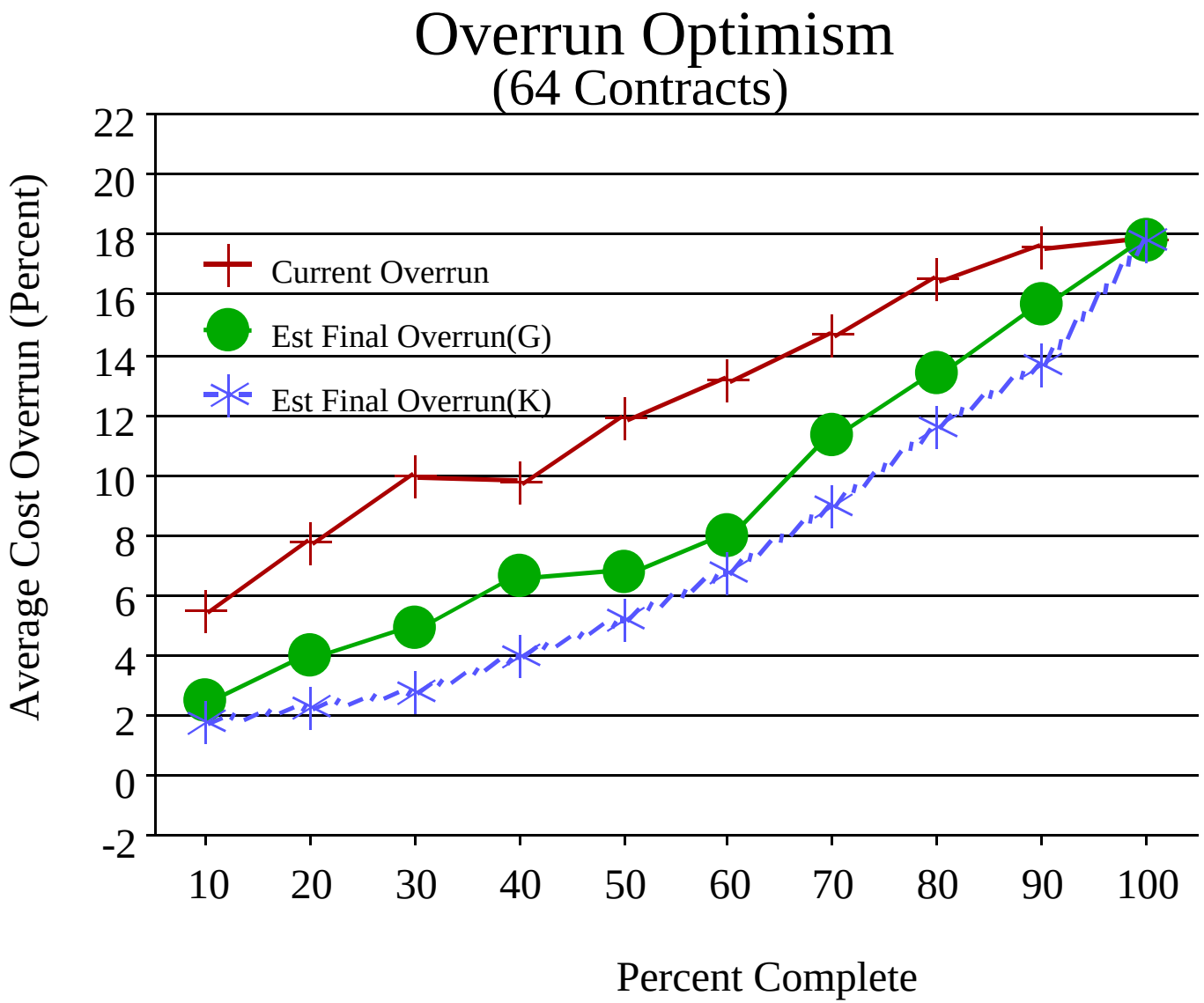
How did the government and contractor estimates compare to this range?

(Christensen, 1996)

EAC Comparisons
(64 contracts)



(Christensen, 1996)



(Christensen, 1994)

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